Appendix C

FINAL INSPECTION FORM

INEEL FIRE PROTECTION INSTALLATION
FINAL INSPECTION FORM

Sprinkler Contractor name and address	_____ _____ _____
Facility Inspected Building/System No./ Control Valve No.	_____ _____ _____
Inspection by: Name Address Phone	_____ _____ _____ _____ PE or CET No _____

I have personally inspected the automatic sprinkler system referenced above and found it to be installed in accordance with the approved working drawings and associated review comments. The attached As-Built drawings and hydraulic calculations reflect the installation as it presently exists.

The following is the results of the main drain test conducted during my inspection:

Static Pressure: _____ Psig
Residual Pressure: _____ Psig

I certify that all areas of the building covered by the above referenced system have been protected in accordance with NFPA, Factory Mutual, and the project specifications, and all signs and placards have been installed.

_____ Date:
(Signed by PE or CET)

Comments or Exceptions: _____

SECTION 16000--ELECTRICAL GENERAL PROVISIONS

PART 1--GENERAL

SUMMARY:

The Subcontractor shall provide, install, terminate, and test all the systems as described in the specification and shown on the drawings to make complete and operational electrical systems.

Section Includes: Work includes, but is not limited to:

[EDIT AS REQUIRED]

Power distribution including transformers, feeders, panels, and safety switches.

Normal and emergency lighting including lighting controls.

Normal and [standby] [emergency] power distribution including controls.

Fire Alarm System (FAS), Emergency Communications (ECS), telephone (TELE), and data systems.

Lightning protection, power system grounding, data, and communication system grounding.

[EDIT AS REQUIRED]

Related Sections:

02200	Earthwork (duct bank installation)
03300	Cast-In-Place Concrete
08100	Doors, Frames, and Hardware (electrical door openers)
15400	Piping and Plumbing Systems (water heaters, drinking fountains)
15501	Wet Pipe Fire Protection System (Life Safety)
15502	Fire Protection Halon System (Life Safety)
15503	Deluge Fire Protection (Life Safety)
15504	Preaction Fire Protection System
15506	On-Off Multicycle Preaction Fire Suppression System (Life Safety System)
15800	Heating and Cooling System
15801	Air Distribution System
15803	HEPA Filter Housings

REFERENCES:

The following documents, including others referenced therein, form part of this section to the extent designated herein. Unless otherwise indicated, use the latest edition in effect as of the date of these specifications.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C-2 National Electrical Safety Code (NESC)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA-70 National Electrical Code (NEC)

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Subpart S OSHA Electrical Safety

UNDERWRITERS' LABORATORIES, INC. (UL)

SUBMITTALS:

See Section 01300, Submittals, other electrical sections and the Vendor Data Schedule for submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with the following codes and standards, except as modified herein:

Underwriters Laboratories (UL): All materials, appliances, equipment or devices shall conform to the applicable standards of Underwriters Laboratories, Inc. All material, appliances, equipment or devices shall be listed and/or labeled by UL or other nationally recognized testing laboratories such as the CSA.

Completed electrical system shall conform with applicable provisions of the Special Conditions, the Technical Specification, and the subcontract drawings.

PART 2--PRODUCTS

GENERAL:

Furnish all labor, materials, equipment and appliances required to complete the installation of the complete electrical systems. All labor, materials, service, equipment, and workmanship

shall conform to the applicable chapters of the National Electrical Code NFPA 70, the National Electrical Safety Code (NESC), Occupational Safety and Health Administration (OSHA), and the terms and conditions of the electrical utility. All modifications required by these codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor.

MANUFACTURERS:

Where multiple units of a product are required for the electrical work, provide identical products by the same manufacturer without variations except for sizes and similar variations as indicated.

MATERIALS:

Except as otherwise indicated, furnish new electrical products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of the product, or required by governing regulations.

Unless otherwise indicated by the drawings or specifications or approved in writing, the materials and/or equipment furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment, and shall be the manufacturer's standard design.

Labeling: Install permanent labels on all electrical panels, cabinets, disconnects, motor starters, major equipment or components, receptacles, and switches. See Section 16195--Electrical Identification for Labeling Requirements.

PART 3--EXECUTION

SEQUENCING/SCHEDULING:

General: It is recognized that the subcontract documents are diagrammatic in showing certain physical relationships which must be established within the electrical work and in its interface with other work, including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Subcontractor.

Arrange electrical work in a neat, well organized manner with conduit and similar services running parallel with the primary lines of the building construction, and with a minimum of 7 ft-0 in. overhead clearance.

Locate operating and control equipment properly to provide easy access, and working clearance in accordance with the NEC.

Advise other trades of openings or clearances required in their work for the subsequent move-in and assembly of large units of electrical equipment.

Electrical connections shall be tightened to torque specifications stated by the equipment manufacturer.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: Upon completing installation of all systems and equipment, but prior to project close out, the Subcontractor shall conduct an operational test of all equipment, controls and devices installed or modified by the Subcontractor. All equipment shall test satisfactory or be repaired or replaced at no additional cost to the Contractor.

The Subcontractor shall test all devices in the presence of the Contractor's Representative. Subcontractor shall coordinate testing with the Contractor and schedule testing a minimum of 2 weeks in advance of the test. The Subcontractor shall inform the Contractor in writing of the scheduled test to allow the Contractor to designate the Contractor's Representative. This operational testing is in addition to testing required in separate sections of this specification.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16000

SECTION 16109--SWITCHES, RECEPTACLES AND WALL PLATES

PART 1--GENERAL

SUMMARY:

Subcontractor shall provide and install switches and receptacles of sizes, ratings, materials and types as shown on the drawings.

Section Includes: Work includes, but is not limited to:

Related Sections:

Section 16000	Electrical General Provisions

REFERENCES:

See the list of general references in Section 16000.

SUBMITTALS:

No Vendor Data required for this section unless an "or equal" item is submitted for review.

PART 2--PRODUCTS

MATERIALS:

Switches: Provide general-duty flush or surface mounted single-pole toggle switches, grounding type with green equipment ground screw, 20 ampere, 120 VAC, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, and side-wired screw terminals. Switches shall be single-pole (double-pole), (3 way) or (4 way) as indicated by the drawing symbols as shown on the drawings. Where more than one switch is shown at an outlet, switches shall be installed under a gang plate in an order appropriate to outlet location.

Switch color shall be Ivory **[Brown]**.

Acceptable manufacturers and models include the following:

Hubble	Model 1121 (single-pole)
Hubble	Model 1122 (double-pole)
Hubble	Model 1123 (3 way)
Hubble	Model 1124 (4 way)
Leviton	Model CS120-2 (single-pole)

Leviton	Model CS220-2 (double-pole)
Leviton	Model CS320-2 (3 way)
Leviton	Model CS420-2 (4 way)
Pass & Seymour	Model 20AC1 (single-pole)
Pass & Seymour	Model 20AC2 (double-pole)
Pass & Seymour	Model 20AC3 (3 way)
Pass & Seymour	Model 20AC4 (4 way)

Receptacles:

General-Duty Duplex: Provide duplex general-duty, flush or surface mounted receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 125 V, with metal plaster ears, side wiring, NEMA Configuration 5-20R unless otherwise indicated on the drawings. Acceptable manufacturers and models include the following:

Hubble	Model 5342
Daniel Woodhead	Model 5352DW
Pass & Seymour	Model 5342

GFCI: Provide general-duty duplex, ground fault circuit interrupter receptacles, feed-through type, capable of protecting connected downstream receptacles on single circuit, grounding type, UL rated Class A, Group 1, 20 ampere rating, 125 V, 60 Hz; equipped with 20 ampere plug configuration NEMA 5-20R. Acceptable manufacturers and models include the following:

Hubble	Model 5352A
Daniel Woodhead	Model 5352GF
Pass & Seymour	Model 2091

Wall Plates: Provide single switch and duplex outlet wall plates for wiring devices, with ganging and cutouts as indicated, provide with metal screws for securing plates to devices, screw heads finished to match plate finish, and with plates possessing the following additional construction features:

Material and Finish/Indoor Use: Cover plates shall be Ivory **[Brown]** color unbreakable nylon or approved equal.

Material and Finish/Outdoor Use: Receptacle covers installed outdoors shall be rain tight with a NEMA 3R rating. They shall maintain this rating even when equipment is plugged in. This shall be accomplished by using flip lids or similar. Cover shall close automatically when released. All components of receptacle cover shall be made of corrosion resistant materials.

PART 3--EXECUTION

INSTALLATION:

Install receptacles, switches and wall plates where indicated on the drawings in accordance with recognized industry installation practices.

Receptacles to be mounted 18 in. from floor unless shown otherwise on the drawings. Switches to be mounted 48 in. from floor unless shown otherwise on the drawings.

Coordinate with other work including electrical raceway and equipment installation work, as necessary to interface installation of wiring and devices with other work.

Install receptacles and switches only in electrical boxes, which are clean and free from building materials and debris.

LABELING:

Label all covers and plates. Install labels per Section 16195 or 16196 for Electrical Identification.

FIELD QUALITY CONTROL:

Site Tests: The Subcontractor or his agents shall perform the following:

Visual inspection to determine that equipment installation conforms to NEC, these specifications and the drawings.

Subsequent to hooking-up cables/wires and devices, energize circuitry and demonstrate functioning in accordance with requirements.

Each receptacle shall be tested with a portable receptacle circuit tester to test for polarity, grounds, and opens. Subcontractor shall furnish a data sheet, listing room numbers or area and number of receptacle tested and test results. Circuit tester shall be Daniel Woodhead No. 1750 or approved equal for standard circuits. GFI receptacles shall be tested with Daniel Woodhead Model No. 1753 or approved equal.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16109

SECTION 16110--ELECTRICAL RACEWAYS

PART 1--GENERAL

SUMMARY:

The Subcontractor shall provide and install electrical raceways for [lighting, power, controls, communications and data systems].

Section Includes: Work includes, but is not limited to:

Provide and install electrical raceways of types, grades, and sizes as shown on the drawings. Provide complete assembly of raceway including, but not necessarily limited to, couplings, elbows, adapters, hold-down straps, and other components and accessories as needed for a complete system.

Coordinate with other work as necessary to interface installation of electrical raceways and components with other work.

[Label all conduits]

Related Sections:

02200	Earthwork
03300	Cast-In-Place Concrete
16000	Electrical Sections

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. See the list of general electrical references in Section 16000.

[ADD OR DELETE REFERENCES AS NEEDED]

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

T99	Standard Method of Test for the Moisture-Density Relations of Soils Using a 5.5-lb (2.6-kg) Rammer and a 12 in. (305 mm) Drop

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	Pipe Threads, General Purpose (Inch)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2 National Electrical Safety Code (NESC)

FACTORY MUTUAL (FM)

UNDERWRITERS' LABORATORIES, INC. (UL)

SUBMITTALS:

[Submittals include, but are not limited to the following:]

[No Vendor Data required for this section unless an "or equal" item is submitted for review.]

[See Section 01300, Submittals, other electrical sections and the Vendor Data Schedule for additional submittal requirements.]

PART 2--PRODUCTS

MATERIALS:

Conduit:

Metal Conduit: Rigid metal (RGS) conduit or IMC shall be used for all conductors where buried in earth, in masonry, in concrete, and in damp or wet locations. All conduit shall be UL approved, 3/4-in. minimum unless shown otherwise on the drawings.

PVC Conduit: Polyvinyl chloride (PVC) conduit shall be heavy wall, Schedule 40, rated 90°C. PVC may be used for telephone, fire alarm, feeders underground, and branch circuits installed under floor slabs. All underground bends, of 30° or more, shall be rigid galvanized steel conduit.

Stainless Steel Conduit: Where required, stainless steel rigid conduit shall be Schedule 10 minimum (304L or 316L stainless) and comply with Section 15400.

All bends shall be completely below finished floor for under floor conduit runs.

EMT: Electrical metallic tubing (EMT) shall be installed in all areas except those stipulated for rigid conduit or IMC. EMT shall be UL approved, standard weight, electro-galvanized steel, 3/4-in. minimum size.

Flexible Conduit: Flexible metal conduit shall be installed in dry locations unless shown otherwise on the drawings. Liquid-tight, flexible conduit shall be installed in wet locations. Liquid-tight flex shall be grounding-type with a PVC jacket.

Fittings: Conduit fittings for rigid conduit (RGS or IMC) shall be rust-resistant cast steel. Conduit fittings for EMT shall be steel, rain-tight compression type.

Junction Boxes: All junction boxes shall be galvanized unless shown otherwise. Small junction boxes (4-11/16 in. square and smaller) shall be stamped from one piece of sheet steel or welded construction and shall be galvanized. Junction boxes used in damp or wet locations shall be type FS/FD with wet location covers.

Cable Trays: Cable tray system shall be made of prefabricated sections, fittings, and accessories as defined in the latest NEMA Standards Publication VE-1. Cable tray shall be made to manufacturing tolerances as specified by NEMA VE1-2-03 and VE1-2-04. The cable tray shall be UL classified as equipment grounding conductors. The cable tray system shall be manufactured by B-Line Systems Inc. or approved equal.

Cable tray shall be capable of carrying the allowable cable load with a safety factor of 2.0 and in addition will support a 200 lb concentrated load without failure.

Cable trays shall be steel or aluminum. Tray types shall be ladder 6, 9, or 12 in. rung spacing, trough or solid bottom.

Steel cable tray sections, fittings, side rails and rungs shall meet the minimum mechanical properties of ASTM A570, Grade 33 for 14 gauge and heavier, ASTM A611, Grade C for 16 gauge and lighter. The cable tray shall be hot-dip galvanized after fabrication in accordance with ASTM A386.

[Aluminum cable tray section and fitting side walls and rungs shall be extruded Aluminum Association Alloy 6063. Fabricated parts shall be made from Alloy 5052.]

[Stainless steel tray sections, fittings and covers and accessories shall be of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.]

Trays shall have an overall nominal depth [4, 5, 6, 7 in.] with a usable loading depth of [3, 4, 5, 6 in.]

Cable tray sections side rails shall be I Beam, C Rail, or Z Rail. All straight sections shall be supplied in standard lengths of [12, 24 ft]; widths shall be [6, 8, 12, 18, 24, 30, 36, 42 in.] or as shown on the drawings or bill of materials. All sections shall be matched and compatible to assembly.

Splice plates shall be the bolted type using either square neck or ribbed neck carriage bolts and serrated flange lock nuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed 0.00033 ohm.

Covers shall be of the solid flanged type and secured in place by heavy duty cover clamps sized for the tray width.

Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concrete placement.

Manholes: Manholes shall be [6' 0" W x 6' 0" L x 7' 0" D minimum][as shown on the drawings]. For each manhole, furnish 1 stanchion for each 30 linear inches of interior floor perimeter. In addition, furnish 1 arm for each stanchion, 3 insulators for each arm, and a total of 3 pulling eyes. Furnish materials complete with associated fasteners, packaged with protective covering for storage and with identification labels clearly describing contents.

For manholes, use 36 in. cover except as indicated.

[IF MANHOLES LOADS ARE SPECIFIED IN THE PRECAST CONCRETE SECTION OROTHER SECTIONS DELETE THE FOLLOWING AND COORDINATE THE ABOVE WITH THE OTHER SECTION]

The manhole and its cover shall be designed for all applicable loads. The minimum live load shall be [pedestrian traffic (a concentrated load of 500 lbs or a uniform load of 100 pounds per square foot (psf) whichever is the worst case)][a AASHTO H-20 truck loading (32,000 lb axle)][a AASHTO H-12 truck loading (15,000 lb axle)] The minimum snow load shall be 30 psf.

Manhole Accessories:

Manhole Frames and Covers: Thirty-six inch diameter minimum, cast iron with words ["Electrical"]["Communications"]["Telephone"] cast into the lid.

Pulling Eyes in Walls: Eyebolt with reinforcing bar fastening insert. Two inch (50 mm) diameter eye, 1 in. (25 mm) by 4 in. (100 mm) bolt. Working load embedded in 6 in. (150 mm), 4000 psi (27.6 MPa) concrete: 13,000 lb minimum tension.

Pulling and Lifting Irons in Floor: 7/8-in. diameter (21 mm), hot-dipped galvanized, bent steel rod, stress relieved after forming and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000-lb shear and 60,000 lb tension.

Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical resistant, nonconductive thermoplastic material; 1/2 in. (12 mm) internal diameter by 2 3/4 in. (68 mm) deep, flared to 1 1/4 in. (30 mm) minimum at base. Tested ultimate pull-out strength: 12,000-lb minimum.

Expansion Anchors for Installation After Concrete is Cast: Zinc-plated carbon steel wedge type with stainless-steel expander clip 1/2 in. (12 mm) bolt size, 5300 lb rated pull-out strength, and 6800 lb rated shear strength minimum.

Cable Stanchions: Hot-rolled, hot-dipped galvanized steel punched with holes for cable arm attachment.

Cable Arms: Hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two, 12 in. (300 mm) wide by 14 in. (350 mm) long and arranged for secure mounting in horizontal position at any position on cable stanchions.

Ground Rods: Solid copper clap steel, 5/8-in. diameter by 10-ft (3 m) length.

Ground Wire: Stranded bare copper, No. 6 AWG minimum.

Ladder: Permanently affixed to avoid contact with cables and racks.

Duct Sealing Compound: Nonhardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35°F (1°C), withstands temperature of 300°F (149°C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

PART 3--EXECUTION

INSTALLATION:

Install and support conduit, tubing and duct products as indicated on the drawings in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation". Comply with recognized industry practices to ensure that products serve intended functions.

Where mounting channel is used, all exposed ends shall be capped. All above grade exposed conduit shall be anchored to mounting channels a minimum of 12 inches long.

Provide flexible conduit for motor connections, and for other electrical equipment connections where subjected to movement or vibration.

Provide liquid-tight flexible conduit for connection of motors and for other electrical equipment where subject to movement or vibration, and also where subjected to one or more of the following conditions:

Exterior locations.
Moist or humid atmosphere where condensate can be expected to accumulate.

Rigid conduit (RGS and IMC) joints shall be cut square, reamed smooth in accordance with the NEC requirements. Joints shall be threaded and drawn up wrench tight in accordance with ASME B1.20.1. Bends or offsets shall be made with standard conduit bending dies that will not injure or flatten the pipe.

Rigid conduit terminating at cabinets and boxes shall be rigidly secured with locknuts inside and outside.

Male threads on exterior runs of galvanized steel conduits shall be thoroughly coated with a conducting sealing media such as petroleum base products. No red lead shall be used on any conduit joint.

All conduit penetrations through building walls, fire walls, or floors shall be sealed around outside of conduits with sealant appropriate for wall material (i.e., grout for concrete walls, fire stop caulk for drywall, etc.). Conduit penetrating exterior walls shall be internally weather sealed. Conduits two in. or greater, passing through fire floors, shall have UL or FM approved internal fire seals.

Where GFE or Contractor supplied security systems (for example, Card Readers and/or door alarms) are to be installed on or near door locations, the door frame can be used as a raceway for wiring of these devices unless the door frame is grouted solid.

Conduit Indentification: Label conduits per Section 16195--Electrical Identification.

Cable Tray Installation: Expansion splice plates shall be installed per the drawings for thermal expansion and contraction.

Cable tray shall be hung from roof trusses and building structural steel using trapeze hangers spaced 8 ft. on center (maximum) and at each turn or intersection. Cable trays shall be routed as not to interfere with HVAC ducting or piping using vertical or horizontal offsets bolted into the tray system. No unbolted jogs or off sets shall be allowed. Trays shall be located minimum of 12 in. above lay-in ceiling.

Cable tray covers shall be installed after cable installation.

Underground Ducts: All underground ducts shall be installed in locations shown on drawings, enclosed in a red concrete casing. Ducts shall be sloped towards manholes in order that all ducts will properly drain. The concrete casing shall also enclose all standard conduit bends or elbows. All underground ducts shall have steel reinforcement under roads and heavy traffic areas in sizes as shown on the drawings. Steel reinforcement is not required in non traffic areas.

Excavate the trenches to provide elevation on top of concrete envelope as shown on drawings. After trenches are excavated and graded, the duct shall be laid in rows on plastic spacers or approved equals.

Spacers shall be so placed that each section of duct is supported at intervals as specified in NFPA 70 (NEC). Concrete shall then be poured until the ducts are covered to the required depth and leveled leaving not less than 3 in. of concrete over top tier of ducts.

[EDIT PARAGRAPH IF EARTHWORK SPEC IS USED]

All trench work shall be backfilled and compacted [per Section 02200--Earthwork] [to at least 95% of the maximum density at optimum moisture content as determined by the AASHTO T-99. Each 8 in. maximum loose measurement lift shall be compacted before the next lift is placed thereon. Samples of compacted backfill failing to meet the minimum compaction requirements shall be corrected prior to placement of subsequent lifts].

Manhole Installation: Cables shall be racked in manholes to meet the cable manufacturers bending radius requirements.

Communication cables shall not be installed in manholes with power cables.

Elevation: Install manholes with roof top at [the grade indicated on the drawings][least 12 in. above finished grade][least 12 in below finished grade]. The top of manhole lids shall be at grade unless otherwise indicated on the drawings.

Access: Install cast-iron frame and cover. Install grade ring to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to grade ring.

Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. After ducts have been connected and grouted, and prior to backfilling, waterproof joints and connections and touch-up abrasions and scars. Waterproof exterior of manhole grade rings after mortar has cured at least 3 days.

Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.

Grounding: Ground exposed metal components and hardware with No. 6 AWG minimum bare copper grounding conductor to manhole ground rod. Turn conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors. [Install 5/8 inch by 10 foot ground rod through the floor of each manhole.]

Precast Concrete Underground Structure Installation: Install as indicated, according to manufacturer's written instructions and ASTM C 891. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances. Support units on a level bed of crushed stone or gravel, graded from the 1 in. (25 mm) sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.

Duct Entrances to Manholes: Space end bells approximately 10 in. (250 mm) on center for 5 in. (125 mm) ducts and varied proportionately for other duct sizes. Change from regular

spacing to end-bell spacing 10 ft (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

Labels: Label each manhole inside the extension ring with 3-inch high letters indicating the proper direction (N, S, E, W).

FIELD QUALITY CONTROL TESTING:

Site Tests: The Subcontractor or his agents shall perform visual inspections to determine that equipment installation conforms to the NEC, these specifications, and the drawings.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work with the drawings and specifications.

END OF SECTION 16110

SECTION 16119--PRECAST MANHOLES AND HANDHOLES

PART 1--GENERAL

WORK DESCRIPTION:

Provide all plant, labor and materials required to construct and install precast manholes and handholes complete with reinforcing, grout, joint sealer and accessories as indicated on the drawings and specified herein. Work includes but is not limited to: Constructing and installing precast concrete manholes and handholes.

QUALITY ASSURANCE:

Manufacturer: Precast concrete units shall be supplied by a company regularly engaged in the manufacture of such products and having a recognized background in such work. Manholes and pullboxes shall be designed and constructed to support specified loads and conditions.

Welding: Qualify welding processes operators in accordance with AWS D1.1 "Standard Qualification Procedure."

Codes and Standards: The following codes and standards shall govern the work except as modified herein:

AMERICAN SOCIETY TESTING MATERIALS (ASTM)

ASTM C857	Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C858	Underground Precast Concrete Utility Structures

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HS-20	Traffic Loading

Related Sections:

16110	Electrical Raceways

Inspection: Factory inspection of precast concrete structures shall be arranged for by the Subcontractor at no cost to the Contractor. This shall not relieve the Subcontractor of responsibility for compliance with this Specification and accuracy of work in all details. The Subcontractor shall notify the Contractor a minimum of 5 days prior to casting of concrete structures.

SUBMITTALS:

See Vendor Data Schedule

Shop Drawings: Provide shop drawings that indicate fabrication and erection requirements, details of joints, reinforcements, stanchions, ladders, pulling eyes, accessories and lifting devices.

Structure Calculations: Provide structural calculations of manholes and handholes to verify compliance with applied loads.

PART 2--PRODUCTS

DESIGN REQUIREMENTS:

Precast manholes and handholes including accessways, duct terminators, access openings and sumps shall be designed in accordance with AASHTO requirements for HS20-44 truck load rating. Structures shall support imposed loads with required openings.

All items shall be capable of withstanding imposed lifting and handling loads. Do not lift precast units until concrete has obtained a minimum of 3500 psi compressive strength as determined by test cylinders. If higher strength prior to lifting is required by design, the higher value shall govern.

MATEIALS:

Concrete and Related Materials: Concrete, reinforcing and miscellaneous concrete-related materials shall comply with requirements of Section 03300. Concrete shall be Class 40 minimum.

Metal Accessories: Metal frames and covers shall be gray cast iron, ASTM A48, Class 30, designed for AASHTO HS-20 loading. The words "CONFINED SPACE-CAUTION 15 KV ELECTRIC" shall be cast into the lids of the manholes used on the 15KV system, the words "CONFINED SPACE-CAUTION ELECTRIC" shall be cast into the lids of the manholes used on other electrical systems. The word "COMMUNICATIONS" shall be cast into the lid of the handholes used for routing data/communications systems.

FABRICATION:

General: Fabrication of underground utility structures shall conform to requirements of ASTM C858.

Joints: Provide single joint design on units of the same size and type to ensure interchangeability. Provide self-aligning joints in sectional units. Underground joints shall be sealed. The joint between the manhole cover slab and the manhole walls shall not be

sealed on this project. It is necessary to be able to remove the cover on a future project to install the electrical cables. Joint sealant shall comply with ASTM C990, preformed flexible joint sealants.

Lifting Devices: Provide each precast section with manufacturer's standard lifting devices designed to support imposed loading.

Framing Channel: Framing channel to support cable racking shall be cast into and made flush with the wall of the manhole. Two sections of framing channel shall be spaced as three equal spaces along each wall. Minor adjustments of spacing may be made to avoid conflict where the conduits enter the manhole. The framing channel shall be Unistrut or B-Line Products and shall extend from the floor to within 1 ft. of the lid.

Pulling Eyes: Provide two pulling eyes on opposite walls of where the conduit enters the manhole. One shall be within 1 ft. of the bottom of the manhole and the other toward the top manhole to avoid conflict with other conduits. The pulling eyes shall be rated for a minimum of 5000# of pull out strength.

Bonding: Reinforcing steel, framing channel, pulling eyes and other conducting material shall be bonded together and connected at a single exposed grounding strap for grounding. One hundred percent of the crosses in the reinforcing steel shall have a physical tie to provide proper bonding. Bonding ribbon shall be placed so that there is a double thickness of ribbon as it comes through the wall of the manhole or handhole. Bonding of the conducting material in the lid of the manhole will not be required.

PART 3--EXECUTION

Manhole Installation: Cables shall be racked in manholes to meet the cable manufacturers bending radius requirements.

Communication cables shall not be installed in manholes with power cables.

Elevation: Install manholes with roof top at [the grade indicated on the drawings][least 12 in. below finished grade]. The top of manhole lids shall be at grade unless otherwise indicated on the drawings.

Access: Install cast-iron frame and cover. Install grade ring to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to grade ring.

Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. After ducts have been connected and grouted, and prior to backfilling, waterproof joints and connections and touch-up abrasions and scars. Waterproof exterior of manhole grade rings after mortar has cured at least 3 days.

Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms and insulators as required for installation and support of cable and conductor and as indicated.

Grounding: Ground exposed metal components and hardware with No. 6 AWG minimum bare copper grounding conductor to manhole ground rod. Turn conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors. Install 5/8 inch by 10 foot ground rod through the floor of each manhole.

Precast Concrete Underground Structure Installation: Install as indicated, according to manufacturer's written instructions and ASTM C891. Install units plumb and level with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances. Support units on a level bed of crushed stone or gravel, graded from the 1 in. (25 mm) sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.

Duct Entrances to Manholes: Space end bells approximately 10 in. (250 mm) on center for 5 in. (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 ft. (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

Labels: Label each manhole inside the extension ring with 3 inch high letters indicating the proper direction (N, S, E, W).

INSPECTION:

Requirements of ASTM C857 and C858 shall apply.

Determine field conditions by actual measurements and verify that conditions are acceptable for placement of units. Correct all deficiencies prior to placement.

The Contractor reserves the right to inspect all phases of the construction of the manholes and handholes including but not limited to the placement of reinforcing steel, bonding of conducting materials, forming, placement of blockouts, placement of concrete and other items of construction. Out of tolerance items shall be repaired or replaced at no additional cost to the Contractor.

INSTALLATION:

Erect structures plumb, level to elevations indicated; and in accordance with manufacturer's recommendations. Place structure on undisturbed or compacted backfill only. Avoid soiling, cracking, chipping of concrete, and damage to built-in items.

LABELING:

Label each manhole and handhole wall with N for North, E for East, W for West, S for South. Each letter shall be 5 inches high and colored black. The letter shall be stenciled and centered on the manhole wall, 5-6 feet from the floor. Lettering shall be stenciled one foot from the top of handholes.

Label inside of manhole and handhole entry including existing manholes, and handholes with number label for the manhole or handhole as shown on the drawings. Labels shall be 5 inches high labeled in black stencil.

See Section 16195 Electrical Identification for additional labeling requirements.

FIELD QUALITY ASSURANCE:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the Drawings and this Specification.

END OF SECTION 16119

SECTION 16120--CABLE, WIRE, CONNECTORS AND MISCELLANEOUS DEVICES

PART 1--GENERAL

SUMMARY:

The Subcontractor shall furnish, install, and terminate all cables, conductors, and devices to make complete and operational systems for this project.

Section Includes: Work includes but is not limited to:

Provide and install cables, wires, and wiring connectors of sizes, ratings, materials and types as shown on the drawings.

Related Sections: See other related sections for specific cables, wire, labels, and testing requirements.

16000 Electrical General Provisions
16195 Electrical Identification

REFERENCES:

The following documents, including others referenced therein, form part of this specification to the extent designated. Unless otherwise indicated, use the latest edition in effect as of the date of this specification.

INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS INC. (IEEE)

IEEE 576	Recommended Practice for Installation, Termination, and Testing of Insulated Power Cables as Used in the Petroleum and Chemical Industry
IEEE 1202	Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies

NATIONAL ELECTRICAL CABLE ASSOCIATION (NECA)

Standard for Installation Practices

UNDERWRITERS LABORATORIES, INC. (UL)

UL 1277	Electrical Power and Control Tray Cables with Optional Optical Fiber Members
UL 1581	Electrical Wires, Cables, and Flexible Cords

SUBMITTALS:

Submittals include, but are not limited to the following:

[LIST SUBMITTALS]

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

PART 2--PRODUCTS

WIRING MATERIALS, 600 V:

Conductors shall be stranded for all sizes of wire and cable larger than 10 AWG.

Conductors shall be copper for all sizes.

Wire insulation shall be Type THHN/THWN or XHHW for all 600 V conductors unless otherwise noted.

Minimum size of power conductors shall be No. 12.

Wiring shall be color coded as indicated below:

Conductor Code Color

Conductor	208/120 Volts*	480/277 Volts	240/120 Volts*
Phase A	Black	Yellow	Black
Phase B	Red	Orange	Red
Phase C	Blue	Brown	
Neutral	White	Gray	White
Ground	Green	Green	Green
DC +	Red**		
DC -	Black**		

* For new circuits installed in existing panels only, black may be used for any phase conductor, white for neutral and green for ground.

** DC conductors colors shall conform to the chart or to NFPA 79.

For large conductors not generally furnished with colored insulation, identification shall be achieved by the use of plastic tape or sleeves of the appropriate color. Yellow phase tape shall consist of two separate bands at each application point in order to avoid confusion with

white, gray, or orange after aging. All wire markers and phase tape shall be covered by clear heat shrink sleeving.

CONNECTORS:

Connectors shall only be used as specified by manufacturer.

Spring type pressure connectors such as "Scotchlock," shall be used for splicing No. 8 and smaller.

Splitbolt and/or lug type connectors such as "Burndy," shall be used for splicing No. 6 and larger.

Crimp on spade or ring tongue lug connectors for connection to terminal boards such as "Stakon," shall be used.

Wire/Device Identification: All conductors shall be identified with self-adhering, oil and moisture resistant vinyl labels, covered with clear heat shrink tubing or white heat shrink tubing with black typed on letters with non-smear ink as manufactured by Brady, T&B or approved equal. Hand lettered labels shall not be used. All conductors shall be labeled with point-to-point destination as shown on the drawings.

PART 3--EXECUTION

INSTALLATION:

General: Install electrical cable, wire and connectors as indicated on the drawings, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure products serve intended functions.

Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

Pull conductors together where more than one is being installed in a raceway. Do not exceed the conductor manufacturer's recommended pulling tension.

Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or insulation.

Use pulling means including fish tape, cable, or rope which cannot damage raceway.

Keep conductor splices to a minimum.

Install splices and taps which have mechanical strength and insulation rating equivalent-or-better than conductor.

Use splice and tap connectors which are compatible with conductor material.

QUALITY CONTROL TESTING:

Subcontractor Supplied Testing:

Meggering: Prior to terminating, test cable or wire of 25 ft or longer for insulation resistance with megger (500 V megger for 300 V insulation and 1000 V megger for 600 V insulation). Any wire with less than 10 megohms to ground or other conductors shall be replaced before proceeding with the terminating. List conductors tested on required test data submittal sheet.

Electrical Continuity: After conductor connectors are installed and conductors are labeled, but prior to termination to terminals or devices, an electrical continuity test shall be performed on each conductor using a battery powered buzzer or ohmmeter to determine that all power, control, grounding and other conductors are properly installed and identified. List all conductors tested on required test data submittal sheets. The Subcontractor shall provide the Test Data Submittal Sheets.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16120